

1. Welcome to Physics 132

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Welcome

Hello, welcome to Physics 132 at University of Massachusetts, Amherst! This course is where we get to use the ideas from Physics 131 (forces, energy, etc.) to really understand two fundamental objects: electrons and light. These two fundamental objects are all around you. You can see this page due to light. How many electronic devices are you carrying right now? Moreover, understanding these two objects is key for understanding the physical origin of biological processes. As a simple example, photosynthesis essentially uses light energy to move electrons around and store it as chemical potential energy. The goal of this course is to develop an understanding of what light and electrons are at a fundamental level.

Introduction to the Course

Light and electrons, these are two of the most basic building blocks of the Universe; they are always surrounding you. Moreover, these two fundamental components of nature are key to understanding modern biology. One cannot hope to understand molecular pathways within cells such as photosynthesis and neural activations without talking about electrons and light, but what *are* electrons? What *is* light? The goal of this course is to help you develop your own understanding of these questions.

How do you define what something is? Especially, as is the case for light and electrons, when the object you are trying to define is subatomic and so very far removed from our everyday experience? These are not scientific questions, we cannot design an experiment to test their answers. Thus, this physics course must, right out of the gate, go beyond physics to philosophy, specifically metaphysics a branch of philosophy that explores the nature of being, existence, and reality. The word *physics* actually comes from a Greek word

meaning nature. Beyond in Greek is

or meta so metaphysics literally means *beyond nature*. In particular, *ontology* is the branch of metaphysics we need to answer the question of “how do you define what something is?”

So how will we define things like electrons and light? In philosophy, we would ask, “what will be our ontological framework?”

We will construct definitions by:

- Listing what characteristics objects have
- Listing how objects interact with other constructs

Thus, our definition of an electron will be a list of its properties and interactions. In defining light and electrons in this way, we will see that we must actually look at two other objects: electric and magnetic fields to

complete our picture. Does listing properties and interactions *really entirely define* what it means to be an electron or light? Probably not! There are certainly other possible ontological frameworks, but those are topics for a philosophy class. Science is a powerful way to understand the world, but its requirement of experimental falsifiability does have limitations which is why general education courses are so important for scientists!

How to Use this Book

This book has been specifically designed for this course out of free-and-open resources such as the OpenStax College Physics textbook (<https://openstax.org/details/college-physics>), University of Maryland's UMD NEXUS Wikibook ([http://umdberg.pbworks.com/w/page/90716129/Working%20content%20I%20\(2015\)](http://umdberg.pbworks.com/w/page/90716129/Working%20content%20I%20(2015))) and ([http://umdberg.pbworks.com/w/page/104048687/Working%20content%20I%20\(2016\)](http://umdberg.pbworks.com/w/page/104048687/Working%20content%20I%20(2016))), as well as other resources from around the internet. While the text has all the information you need, some sections are also available as videos on our course YouTube page LINK. These sections will have the link at the beginning with the section below.

Many students often complain that physics lectures, “spend all of their time on the easy problems and never have time to work through harder ones.” In this course, we want to make sure that you have time to work through harder ideas and problems in-class where you can get help from the TAs and instructor. To make sure we have time to explore these concepts, you will need to have some familiarity with basic facts before coming to class. We will expect you to learn the relevant formulas, symbols, and terminology as well as review relevant material from 131 before coming to class. We will NOT expect you to learn how to solve new types of advanced problems. This style of class, with the expectation of completing readings first is called a *flipped classroom* and is based on research (Stoltzfus, Matthew W. “Active Learning in the Flipped Classroom: Lessons Learned and Best Practices To Increase Student Engagement.” In *The Flipped Classroom Volume 1: Background and Challenges*, 1223:105–22. ACS Symposium Series 1223. American Chemical Society, 2016.<https://doi.org/10.1021/bk-2016-1223.ch008>.) There will also be homework to help you learn this material, the details of which we be described in-class and/or in the syllabus. Finally, at the beginning of each unit, there will be a quiz to ensure you are ready for the in-class activities. If you complete and understand the reading and homework, you should be ready for these quizzes. The purpose of this book is to help you be ready for these homework and quizzes.

This book, like the course, is divided into units. Each unit will begin with a “Unit on a Page” which summarizes the key points of the unit, both prep and in-class, on a single page. Due to the constraint of fitting on a single page, these pages are necessarily dense. The goal is to help you focus on the underlying themes, see what is really important. I would recommend you print these pages and keep them with you both during your prep and in-class to help you see the big picture.

After the “Unit on a Page” there will typically be an introduction to the unit followed by the sections. Within these sections, there will be UMass-Amherst Instructor’s Notes like the one below which will tell you exactly what you need to focus on to be ready for the quizzes.

Exercise:

UMASS
AMHERST Instructor's Notes

Problem:

Pay attention to these as they tell you exactly what material will be on your quiz!

We encourage your feedback on this book. If you have suggestions for comments or would like to report an error, please go to <https://goo.gl/forms/VQaiFUtKD1PxJfH83> and complete the form.

We hope this book is helpful!

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